CLAIMS

WHAT IS CLAIMED IS:

1. A method for determining an estimated velocity of a fluid through a flow meter having at least one failed chord and at least one non-failed chord, the method comprising:

determining the measured flow velocity from each of the non-failed chords;

maintaining a plurality of velocity bins, wherein each bin contains a proportion value;

determining an estimated proportion for each of the measured flow velocities using the proportion values maintained in the plurality of velocity bins; and

determining the estimated velocity from the measured flow velocities and the estimated proportions.

2. The method of claim 1 wherein the plurality of velocity bins are maintained while there are no failed chords by initializing a plurality of bins with default values, each default value having a proportion value.

3. The method of claim 2 wherein each default value further comprises a velocity value.

4. The method of claim 1, further comprising:

determining an average flow velocity using a measured velocity from each chord;

determining a proportion value for each chord by dividing the velocity measured by the chord by the average flow velocity; and

updating the proportion values in the bins using the measured velocities and determined proportion values, wherein once a proportion value has been updated the bin is considered trained.

5. The method of claim 4 wherein the proportion values are updated as long as there are no failed chords.

6. The method of claim 1 wherein the estimated proportion for each measured flow velocity is considered to be the proportion value for the trained bin which corresponds to the measured flow velocity.

7. The method of claim 1 wherein the estimated proportion for each measured flow velocity is determined by interpolating between two trained bins if the measured flow velocity is between the velocity values of the two bins.

8. The method of claim 1 wherein the estimated proportion for each measured flow velocity is considered to be the proportion value for the trained bin with the highest velocity value if the measured flow velocity is greater than the highest velocity value of the bins.

9. The method of claim 1 wherein the estimated proportion for each measured flow velocity is considered to be the proportion value for the trained bin with the lowest velocity value if the measured flow velocity is less than the lowest velocity value of the bins.

10. The method of claim 1 wherein each chord has ten velocity bins for flow in each of two directions through the meter.

11. The method of claim 1 wherein the estimated velocity is determined by dividing the summation of the measured flow velocities by the summation of the estimated proportions.

12. The method of claim 1 wherein the estimated velocity is determined by summating the measured flow velocity from each of the non-failed chords divided by its corresponding stored proportion value and dividing the summation by the number of non-failed chords.

13. An ultrasonic flow meter suitable for determining the average flow velocity in a pipe, the flow meter comprising:

at least two pairs of ultrasonic transducers, each pair of transducers capable of transmitting ultrasonic signals along a chord; and

a processor suitable to maintain a plurality of velocity bins by a method comprising:

determining an average flow velocity using a measured velocity from each chord;

determining a proportion value for each chord by dividing the measured velocity by the average flow velocity; and

updating the proportion values in the bins using the measured velocities (V_{chord}) and determined proportion values ($Prop_{chord}$).

14. The flow meter of claim 13 wherein the method further comprises initializing a plurality of bins with default values, each default value having a proportion value.

15. The flow meter of claim 13 wherein once a proportion value has been updated the bin is considered trained.

16. The flow meter of claim 13 wherein at least one chord is failed and at least one chord is non-failed, said processor is adapted to perform a method comprising:

determining the measured flow velocity from each of the non-failed chords;

maintaining a plurality of velocity bins, wherein each bin contains a proportion value;

determining an estimated proportion for each of the measured flow velocities using the proportion values maintained in the plurality of velocity bins; and

determining the estimated velocity from the measured flow velocities and the estimated proportions.

17. The flow meter of claim 13 wherein at least one chord is failed and at least one chord is non-failed, said processor is adapted to perform a method comprising:

determining the measured flow velocity V_{chord} from each of the non-failed chords;

determining an estimated proportion $Prop_{chord}$ for each of the measured flow velocities using the values maintained in the plurality of velocity bins; and

determining the estimated average velocity by the following equation

$$V_{est\ avg} = \frac{\sum_{\substack{Non-Failed \\ Chords}} V_{chord}}{\sum_{\substack{Non-Failed \\ Chords}} \Pr op_{chord}}.$$

18. The flow meter of claim 13 wherein the average flow velocity is calculated according to the equation:

$$V_{wtd\ avg} = \sum_{\substack{Active \\ Chords}} Wt_{chord}\, V_{chord},$$

wherein $V_{wtd\ avg}$ is the average flow velocity, Wt_{chord} is a geometry-dependent constant, and there are no failed chords.

19. The flow meter of claim 13 wherein at least one chord is failed and at least one chord is non-failed, said processor is adapted to perform a method comprising:

$$V_{avg} = \frac{\sum_{i=1\ldots n} \frac{V_i}{\Pr op_i}}{n};$$

wherein $Prop_I$ is the proportion value for a non-failed chord, V_I is the measured velocity for a chord, n is the number of non-failed chords, and V_{avg} is an average flow velocity.

20. The flow meter of claim 16 wherein the estimated proportion for each measured flow velocity is determined by interpolating between two trained bins if the measured flow velocity is between the velocity values of the two bins.

21. The flow meter of claim 16 wherein the estimated proportion for each measured flow velocity is considered to be the proportion value for the trained bin in which the measured flow velocity is contained.

22. The flow meter of claim 16 wherein the estimated proportion for each measured flow velocity is considered to be the proportion value for the trained bin with the highest velocity value if the measured flow velocity is greater than the highest velocity value of the bins.

23. The flow meter of claim 16 wherein the estimated proportion for each measured flow velocity is considered to be the proportion value for the trained bin with the lowest velocity value if the measured flow velocity is less than the lowest velocity value of the bins.

24. The flow meter of claim 16 wherein each chord has ten velocity bins for flow through the meter in at least one direction.